

## EFFECTS OF CONTAMINATED HEAVY METAL INDUSTRIAL SLUDGE WASTE ON GERMINATION AND SEEDLING GROWTH OF BRINJAL (*SOLANUM MELONGENA L.*)

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### ABSTRACT

The present study deals with the “Effects of Contaminated Heavy metal Industrial sludge waste on germination and seedling growth of *Solanum melongena L.*” (Brinjal) plant Species were investigated in laboratory by conducting a general Petridish test and growth inhibition assessment. Brinjal Species of plants i.e., *Solanum melongena L.* were used in order to investigate plant’s ability to germinate and survive in a gradient of contaminated solid waste with heavy metals like Copper (Cu), Zinc (Zn), Iron (Fe) and Manganese (Mn) were found in the Industrial sludge. The results indicate that effect of ISW on Germination time and viability of germination seeds also found. Compared to the Control WE<sub>1</sub> 82.02(%), WE<sub>2</sub> 66.02(%), WE<sub>3</sub> 61.09(%) and WE<sub>4</sub> 52.81(%) of total germination effected and decreased.

**KEYWORDS:** Germination, Heavy Metal, Industrial Sludge Waste, Seedling Growth, *Solanum melongena L.*

### INTRODUCTION

The Industrial sludge especially those in hazardous waste sites are contaminated with heavy metal e.g. Copper, Zinc, Iron and Manganese. Industrial and agricultural activities have contributed to the increasing occurrence of heavy metals in the ecosystem (Vinit-Dunand *et al.*, 2002). In fact, heavy metals are a natural part of terrestrial systems, occurring in soil, rock, air, water, and organisms (Reichmann, 2002). Generally, heavy metal toxicity issues can not arise in natural soils with their native vegetation. Even if the soil is naturally high in a particular metal, native plants will often have become adapted over time to the locally elevated levels (Brooks et al., 1992; Ozounidou *et al.*, 1994). Heavy metals such as manganese (Mn), copper (Cu), iron (Fe), zinc (Zn) and nickel (Ni) are essential mineral nutrients for higher plants. Cu is a component of several electron transport enzymes and is involved in catalyzing the redox reactions in mitochondria and chloroplasts (Marschner, 1995). However, Cu also induces to toxicity in tissue concentrations slightly above its optimal levels (Fernandes & Henriques, 1991). Excess Cu in soil in not only from it is increasing use industry, like mining and smelting, but also from its use as a pesticide (e.g., the Bordeaux mixture), and it is also presence in sewage sludge amendmets (El-Nennah *et al.*, 1982; Vinit-Dunand *et al.*, 2002). Zinc toxicity in plants limited the growth of both root and shoot (Malik *et al.*, 2011). Zinc is one of the micronutrients essential for normal growth and development of plants as it is known to be required in several metabolic process (Nazar khan., 2013). Iron toxicity in tobacco, canola, soybean and *Hydrilla verticillata* are accompanied with reduction of plant photosynthesis and yield and the increase in oxidative stress and ascorbate peroxidase activity (Sinha *et al.*, 1997). Mn is readily transported from root to shoot through the transpiration stream, but not readily remobilized through phloem to other organs after reaching the leaves (Loneragan., 1988). Necrotic brown spotting on leaves, petioles and stems is a common symptom of Mn toxicity (Wu., 1994).

*Solanum melongena L.*, species is a member of the Solanaceae family, grown extensively in central, southern, and

Southeast Asia, and in a number of African countries (Kalloo, 1993). Metals can also be transported from soil into groundwater resulting in to ground water contamination and inhibiting growth of plants (Sharma et al., 2008). The aim of present study was to investigate the the effects of Industrial sludge waste to Seed Germination on *Solanum Melongena L.* Plant Seeds in Kakinada, E.G. District, Andhra Pradesh, India.

## STUDY AREA

The Kakinada city is the capital of East Godavari District of Andhra Pradesh on the central east coast of India. The present study deals with the “Effects of contaminated heavy metal industrial sludge on germination and seedling growth of *Solanum melongena L.* Kakinada is situated between the latitude 16°57’ North and longitude 82°15’ East. The study was carried out at the *Solanum melongena L.* Seed species were taken from an Agricultural Cooperative Centre at Kakinada, Andhra Pradesh area of East Godavari District.

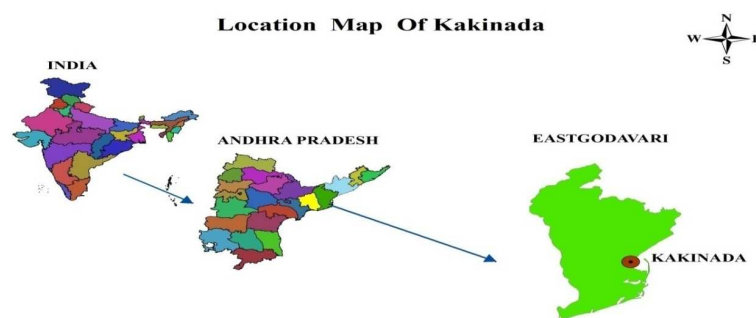


Figure 1: Location Map of Kakinada

## MATERIAL AND METHODS

### Industrial Sludge Waste ion Collect

The Industrial sludge waste samples were collected at the outlet of release channel of the “Oil and Gas Industry” at Kakinada; air-dried and was brought to the laboratory. The dried material was powdered in a mortar.

### SEED MATERIAL COLLECTION

The seeds of (Brinjal) *Solanum melongena L.* variety: were procured from an Agricultural Cooperative Centre at Kakinada, East Godavari district, Andhra Pradesh.

### PREPARATION OF SOLID WASTE EXTRACT

The Solid waste was powdered and 1kg solid waste was mixed with one liter of double distilled water and stirred continuously. Stirring and sedimentation continued for 20 days after which, the supernatant liquid was taken for experimental study. The water extract of the solid waste was analysed for various physico-chemical parameters

## LABORATORY EXPERIMENTS

The seeds of *Solanum melongena L.* were cultured in petridishes, using graded concentrations (5%, 10%, 30% and 50% V/V of ISW) of water extract of ISW corresponding to soil amendments

### GERMINATION EXPERIMENTS

For each experiment, 25 seeds of *Solanum* were taken in sterilized petridishes (15×20 cms) at equal distance.

These were treated with equal doses of different concentrations (V/V) of water extract of the solid waste (5%, 10%, 30% and 50%) as and when necessary. Seeds treated with distilled water were maintained as control. Four replicates were maintained for each treatment including the control. The petridishes were kept under diffused light at room temperature ( $28 \pm 1^\circ\text{C}$ ). Emergence of radical having at least 5mm length was taken as indicative of germination. The Percentage germination was recorded as per the method specified by Carley and Watson (1968). Each Experiment was repeated thrice with six replicates per treatment of 20 seeds on each Occasion. The data were statistically analyzed for LSD at 95% confidence limits (Pause and Sukhatma, 1967).

## RESULTS AND DISCUSSIONS

The Copper, Zinc, Fe and Iron were found 20.89, 16.50, 9.84 and 0.310. Comparatively control WE<sub>1</sub> to WE<sub>4</sub> of pH, Colour, Odour, Electrical conductivity, Available Nitrogen, Available Phosphorus, Exchangeable Potassium, Copper, Zinc, Iron and Manganese levels are increased. (Table- 1 and Fig-2). The germination of time and viability of germination of seeds found. The results indicate that effect of ISW on Germination time and viability of germination seeds also found. Compared to the Control WE<sub>1</sub> 82.02 (%), WE<sub>2</sub> 66.02 (%), WE<sub>3</sub> 61.09 (%) and WE<sub>4</sub> 52.81 (%) % of total germination also effected and decreased

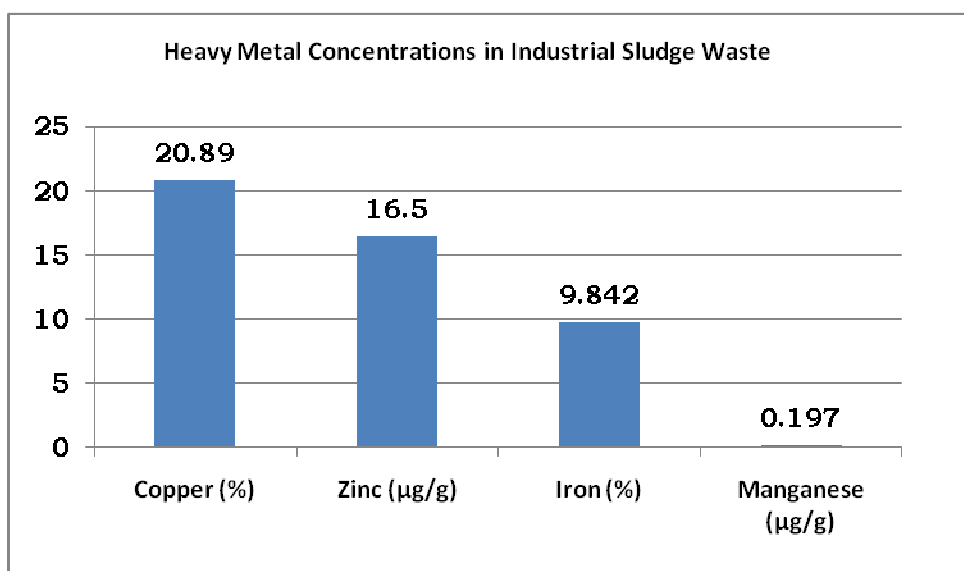


Figure 2: Heavy Metal Concentrations in ISW

Table 1: Physico- Chemical Characteristics of Control & Water Extracts

S.No	Parameters	Control Water & Water Extracts				
		C	WE <sub>1</sub>	WE <sub>2</sub>	WE <sub>3</sub>	WE <sub>4</sub>
1	pH	6.82	5.82	5.82	5.68	5.53
2	Electrical conductivity (Millimhos)	0.812	0.880	0.892	1.078	1.23
3	Copper (%)	0.6	3.8	4.8	7.10	9.86
4	Zinc (%)	14.5	15.9	16.09	17.82	18.90
5	Iron (%)	1.0	2.12	3.61	3.24	3.86
6	Manganese (%)	0.21	0.8	0.10	1.30	1.36

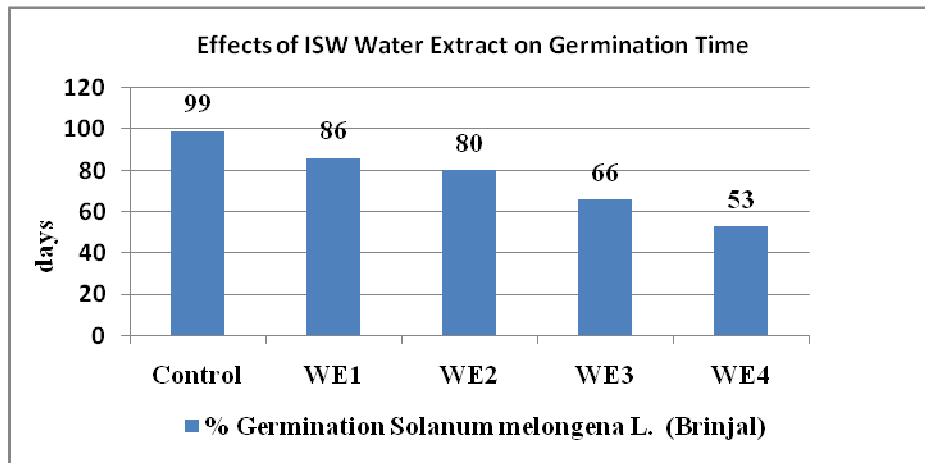


Figure 3: Effects of Industrial Sludge Waste Water Extract on Germination Time

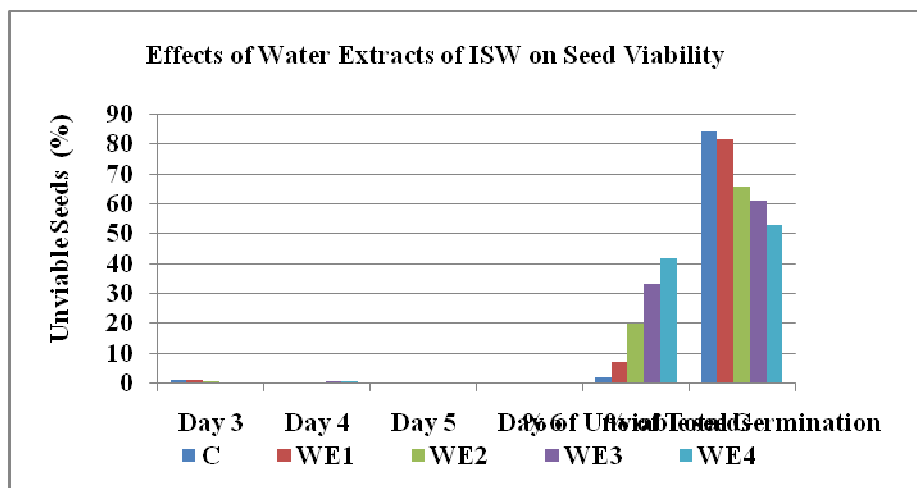


Figure 4: Effect of Water Extracts of ISW on Seed Viability

Table 2: Effect of Water Extracts of ISW on Germination Time and Viability of Germinating Seeds

S. No.	Day 3	Day 4	Day 5	Day 6	% of Unviable Seeds	% of Total Germination
C	83%	17%			2	84.61
WE <sub>1</sub>	78%	15%	4%		7	82.02
WE <sub>2</sub>	53%	24%	7%		20	66.02
WE <sub>3</sub>	6%	41%	14%	4%	33	61.09
WE <sub>4</sub>	4%	26%	15%	4%	42	52.81



Figure 5: Petridish Culture of *Solanum melongena* L. Seeds



Figure 6: Petridishes with Seedling of *Solanum melongena* L.

## CONCLUSIONS

- The water extract of the ISW (1 kg of ISW leached into 1 l of water) had relatively lower concentrations of different elemental constituents and had a pH almost similar to that of the ISW while the Electrical Conductivity has increased slightly.
- The pH of the *WE* of the present study was significantly low in acidity. Owing to the high levels of Cu, Zn, Iron and Manganese in the *WE* of the present study, with every precipitation, the ISW can potentially enhance the Copper, Zinc, Iron and Manganese concentrations in the soils of vicinity.
- Compared to the Control  $WE_1$  82.02 (%),  $WE_2$  66.02 (%),  $WE_3$  61.09 (%) and  $WE_4$  52.81 (%) % of total germination effected and decreased
- Therefore there is a need to implement certain rules that help in the reduction of metal level from a wide range of sources such as from the metal processing industries and oil and gas plants.
- Seedling growth is considered as an indicator of metal stress on plant vigor.
- Their increased concentrations in human food chain over a long time can provoke detectable damage to health.

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